NOBANIS - Invasive Alien Species Fact Sheet

Sander lucioperca

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Bibliographical reference – how to cite this fact sheet:
Larsen, L.K. and Berg, S. (2014) NOBANIS – Invasive Alien Species Fact Sheet – ***Stizostedion lucioperca***. – From: Online Database of the European Network on Invasive Alien Species – NOBANIS www.nobanis.org, Date of access x/x/201x.

Species description

Scientific name: *Sander lucioperca* (L.), Percidae
Synonyms: *Stizostedion lucioperca* (L.)
Common names: Zander, Pikeperch (GB), candát obecný (CZ), sandart (DK), koha (EE), Gjørs (NO), Gös (SE), Kuha (FI), Zander (DE), Starkis (LT), Zandarts (LV), Sudak obyknovennyi (RU), Sandacz (PL).

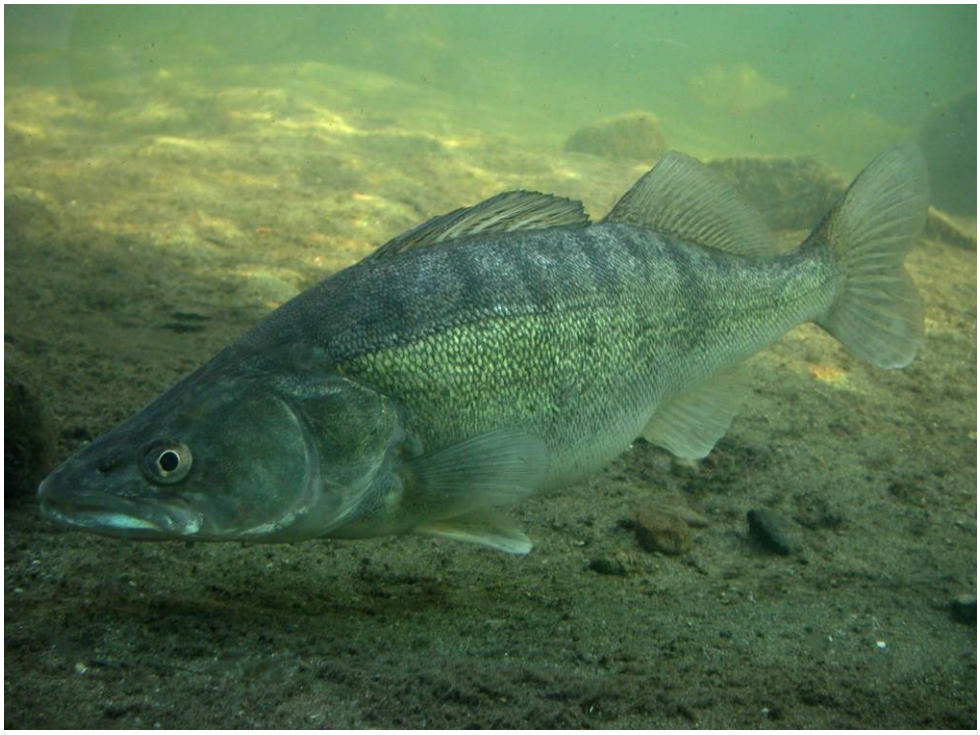

Fig 1. *Sander lucioperca*, photo by Henrik Baktoft.

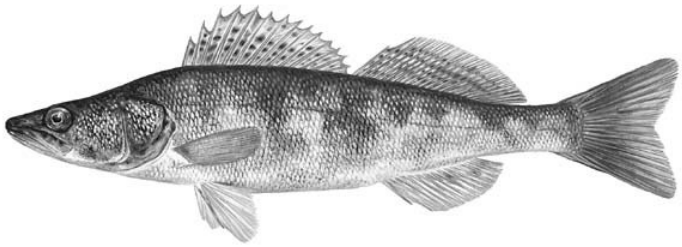

Fig 2. *Sander lucioperca*, drawing from Facts on Fish (Nordic Council of Ministers).

Species identification
S. lucioperca has a long slender body. There are no spines on the gill cover. The mouth has many small teeth and a few larger teeth for catching prey. The species has two dorsal fins – the first with 13 to 18 spines and the second one with 1-2 spines and 21 to 22 soft rays. The caudal fin has 17 soft rays and the anal fin has 2-3 spines and 10-14 soft rays (see Fig. 2).

S. lucioperca obtains a maximum length of 100-130 cm which corresponds to a weight of about 15-20 kg. Maximum age is inversely correlated to growth rate. Slow-growing *S. lucioperca* in the northern part of the distribution area reach 20-24 years of age, while faster-growing *S. lucioperca* in the southern part only reach about 8-9 years (Sonesten 1991).

Native range
S. lucioperca occurs naturally in lakes and rivers of Middle and Eastern Europe from Elbe, Vistula, north from Danube up to the Aral Sea and the northernmost observations of native populations were recorded in Finland up to 64° N. *S. lucioperca* naturally inhabits Onega and Ladoga lakes, brackish bays and lagoons of the Baltic sea. The distribution range in the Baltic area is supposed to be equivalent to the range of the post-glacial Ancylus Lake, which during the period 9200-9000 BP had a water level 100-150 m above the present sealevel of the Baltic Sea (Salminen et al. 2011). The most southern populations are known from regions near the Caucasus, inhabiting brackish and saline waters of Caspian, Azov and Black Seas (Bukelskis *et al.*, 1998). Historic evidence from 1700 and 1800 (two sources) suggests the existence of one natural population in Denmark, in Lake Haderslev Dam and the neighbouring brackish Haderslev Fiord on the east coast of the Jutland peninsula (Berg 2012).

Alien distribution

History of introduction and geographical spread
S. lucioperca has been introduced into several European countries, among others the Netherlands and Turkey (Welcomme 1988), France (Daszkiewich 1999, Keith & Allardi 2001) Italy (Gandolfi *et al.* 1991) and Spain (Elvira 1995). It was first introduced into the UK in 1878 by the Ninth Duke of Bedford (Cacutt 1979). He stocked 23 *S. lucioperca* into two lakes at Bedfordshire from a lake in Schleswig-Holstein in Germany. In 1910 the first reproducing population was established.

The first human introduction of the species in Denmark was in 1879, where 20 *S. lucioperca* from Lake Brogdorf in south Schleswig, Germany, were stocked into the Odense River in Funen. The fish did not survive. In 1898, 200 *S. lucioperca* were successfully stocked into Lake Søgård in southern Jutland. Today more than 70 Danish lakes and rivers contain self-reproducing stocks of *S. lucioperca* (Otterstrøm 1912, Dahl 1982).
In the other three Nordic countries, Sweden, Norway and Finland, *S. lucioperca* is, even though it is native to these countries, the most commonly introduced none-salmonid fish species in new lakes.

This has increased the present range of the originally southernly distributed *S. lucioperca* northwards in these countries. Ca. 2500 lakes > 4 ha have an introduced population of *S. lucioperca* (Rask *et al.* 2000, Tammi *et al.* 2003). In Sweden alone, more than 92 lakes and rivers contain *S. lucioperca* populations as a result of stocking (Filipsson 1994).

The only known natural distribution areas of the species in Lithuania is in the Curonian Lagoon and the lower River Nemunas (Bukelskis *et al.*, 1998; Virbickas 2000). From there this species was introduced into Lake Dysnai before 1940. Numerous successful introductions into many water bodies followed. Currently large populations of pike-perch inhabit the Curonian Lagoon, Kauno, Antalieptes reservoirs, Sartai, Dysnai, Dviragis Lakes, the River Nemunas, etc. (Bukelskis *et al.*, 1998).
In Latvia *S. lucioperca* occur naturally in coastal waters and inner waters connected to the sea. It also occurs naturally in a few lakes and in artificial reservoirs, where populations have established themselves after stocking. *S. lucioperca* has been stocked in at least 94 (12 %) lakes in Latvia, some artificial reservoirs on the Daugava, and the southern part of the Gulf of Riga from 1904 to 1996 (Nature of Latvia).
S. lucioperca occurs naturally in eastern Germany, especially in the German River Elbe and its tributaries. In 1881-1882, *S. lucioperca* was first stocked in western Germany, especially in Lake Constance and in the Rhine (Lehmann 1931). In later years *S. lucioperca* has also been introduced into other areas of Germany.
In Estonia *S. lucioperca* naturally populates the Gulf of Riga, the Väinameri and Narva Bay, occasionally it occurs in coastal waters of other regions. In freshwater it occurs in Lakes Võrtsjärv and Peipsi from where it occasionally migrates into the Emajõgi River, smaller lakes and the Narva Reservoir. Since the end of the 19th century *S. lucioperca* has been successfully introduced into more than 30 moraine lakes in south-eastern and southern Estonia (Ojaveer *et al.* 2003).

Pathways of introduction
S. lucioperca has been introduced for both commercial and recreational fishing – the fish is very tasty and has high market and angling value. Furthermore, the species has been used for biomanipulation in order to reduce the number of unwanted fish, usually cyprinids (Lappalainen *et al.* 2003).

Country	Not found	Not established	Rare	Local	Common	Very common	Not known
Austria					Native		
Belgium					X		
Czech republic					Native		
Denmark				Native			
Estonia					Native		
European part of Russia				X			
Finland						Native	
Faroe Islands	X						
Germany				Native			
Greenland	X						
Iceland	X						
Ireland	X						
Latvia				Native			
Lithuania				Native			
Netherlands							X
Norway				Native			

Poland	Native
Slovakia	X
Sweden	Native

Table 1. The frequency and establishment of *Sander lucioperca*, please refer also to the information provided for this species at www.nobanis.org/search.asp. Legend for this table: **Not found** –The species is not found in the country; **Not established** - The species has not formed self-reproducing populations (but is found as a casual or incidental species); **Rare** - Few sites where it is found in the country; **Local** - Locally abundant, many individuals in some areas of the country; **Common** - Many sites in the country; **Very common** - Many sites and many individuals; **Not known** – No information was available; **Native** – when a species is native in a country this is indicated in the table under the relevant frequency category.

Alien status in region
As described above, *S. lucioperca* is found naturalised as an alien species in a large number of countries in Europe, including countries not mentioned in Table. 1(UK, Italy, Turkey, Spain and France). In addition, the species has been stocked into and established self reproducing populations in other water bodies in countries, where it is native to one part or region of the country. This has happened in Estonia, Finland, Lithuania, Latvia, Germany, Norway, Sweden and Denmark (see table 1).

Ecology

Habitat description
S. lucioperca is found in lakes, moderately running waters and brackish coastal waters with salinities up to ca. 12 ‰. It thrives in turbid, moderately eutrophic waters with high oxygen content. *S. lucioperca* is also found in clear waters if the depth is sufficient to enable it to seek refuge during daytime (Sonesten 1991).

Reproduction and life cycle
Mature (maturation at age 2-5 years) *S. lucioperca* migrate to the spawning area shortly before spawning. The migrations are generally short 10-30 km or absent, but can be rather long, up to 250 km (Sonesten 1991, Koed 2001, Lappalainen *et al.* 2003).

The spawning takes place in lakes and rivers on a substrate consisting of stone, gravel, sand or clay preferably with plant roots. *S. lucioperca* spawn in pairs in springtime (generally in May) when water temperature reaches about 10-14 ^{o}C. For optimal egg development water temperature must be between 12-20 ^{o}C, oxygen concentration above 4.5 mg O_2/l, and salinity less than 3 ‰ (Muus & Dahlstrøm 1984, Sonesten 1991, Lappalainen *et al.* 2003). Populations of *S. lucioperca* living in coastal areas enter adjacent freshwaters for spawning. Sea spawning is, however, observed in the northern part of the Gulf of Riga, where the salinity is sufficiently low (Nature of Latvia).

After hatching (about 110 degree-days) the larvae have a length of 4-5 mm. They feed on small zooplankton, but at a length of 10-25 mm the fry initiate piscivory. When *S. lucioperca* reaches 10 cm the diet almost solely comprises fish (Sonesten 1991).

Dispersal and spread
Most introductions of S. *lucioperca* have been done in lakes. From the lakes the fish have migrated into larger rivers (*e.g.* River Gudenaa in Denmark; Koed 2001), and in some cases have, through

migration, established themselves in neighbouring lakes to the lakes where they were first introduced. In Finland, the extinction of many northern native *S. lucioperca* populations in 1960´s, has been followed by successful re-introductions in 1980´s (Colby & Lehtonen 1994).
In Sweden *S. lucioperca* is still stocked to support fisheries, both within and outside the area of its natural range. 322 permits for stocking *S. lucioperca* were issued in Sweden in the period 1995-2001 (Laikre & Palmé 2005).

Impact

Affected habitats and indigenous organisms
S. lucioperca is piscivorous and normally feed on cyprinids, smelt (*Osmerus eperlanus*), ruffe/pope (*Acerina cernua*) etc. In the springtime *S. lucioperca* also predate on smolts of sea-trout (*Salmo trutta*) and salmon (*Salmo salar*) when they migrate to the sea. Studies from River Gudenaa, Denmark has shown that predation on smolts in the lower part of the river has an adverse effect on the population of sea-trout (Jepsen *et al.* 2000, Koed 2001, Koed *et al.* 2002).

Other adverse effects on natural fish populations, as a result of introduction of *S. lucioperca*, have been described. Schulze *et al.* (2006) found that the perch (*Perca fluviatilis*) population in a shallow, mesotrophic lake with natural occurrence of perch and pike (*Esox lucius*) were negatively affected by *S. lucioperca* introduction. In an experiment they showed that perch was forced away from its preferred habitat, the pelagic zone, by *S. lucioperca*. As the littoral zone was already occupied by pike, the perch population was "sandwiched" between pike and the introduced *S. lucioperca*. As perch has been found to be the most important predator to control the density of zooplanktivorous 0+ cyprinids in Danish lakes, the introduction of *S. lucioperca* must be considered as negative and indeed has been observed to result in reduced environmental conditions compared to the expected in eutrophic Danish lakes (Jerl Jensen & Müller 2002).

Several authors have reported reduced population densities of cyprinids as a result of *S. lucioperca* introduction. Jeppesen *et al.* (2001) found evidence of this in a paleolimnologic study in the Danish Lake Skanderborg, where *S. lucioperca* was introduced in 1903-04. After this a permanent reduction in cyprinid densities was found. Based on theoretical modelling Nilsson (2001) also predicted reduced density of prey fish (roach (*Rutilus rutilus*) in the model) when *S. lucioperca* is introduced to lake ecosystems with pike already present. Cowx (1997) found that introducing *S. lucioperca* to English rivers created a crash in the cyprinid fish community.
Brabrand and Faafeng (1993) showed how young roach shifted from pelagic to littoral habitats as a result of *S. lucioperca* introduction in a Norwegian lake. An indirect effect of the changed behaviour of roach was increased infection rate of roach with the ectoparasite *Ichthyophthirius multifiliis*, as roach was more often exposed to the free swimming state of *Ichthyophthirius multifiliis* when living in shallow water near the substrate compared to their previously more pelagic lifestyle (Brabrand *et al.* 1994).

In the Turkish Lake Egredir *S. lucioperca* was introduced in 1955 and from 1961 it became an important species in commercial fisheries in the lake. The introduction also had the result that 5 out of 9 indigenous fish species disappeared, among these three species of *Phoxinellus*, two of which were endemic to Lake Egredir (Crivelli 1995). Consequently these two species must now be considered extinct worldwide.

Genetic effects

In Finland there is a growing concern about the potential loss of genetic diversity of the native *S. lucioperca* populations due to enhancement stocking with foreign *S. lucioperca*.

Human health effects
High concentrations of toxic compounds from algae-preventing (anti-fouling) paints have been reported in some of the Finnish coastal *S. lucioperca* populations.

Economic and societal effects (positive/negative)
S. lucioperca is a valuable fish – it has a high market value and is a target species in angling. After its introduction to Danish lakes, it soon became an economically very important species in commercial fisheries. At present the value of commercial inland fisheries in Denmark is very low while the value and social importance of recreational fisheries (both local angling and angling tourism) is increasing (Jacobsen *et al.* 2004). In the Turkish Lake Egredir, the value of commercial fisheries increased several fold after the introduction of *S. lucioperca*, both because the indigenous fish species had a low commercial value compared to *S. lucioperca*, and due to a drastic increase in the population of *Astacus leptodactylus*. In 1981 fisheries yield were 310 tonnes of *S. lucioperca* and 1573 tonnes of *A. leptodactylus* (Crivelli 1995). Before 1965 the commercial catch of *A. leptodactylus* was zero. After ca. 1990 the commercial value of the fishery in Lake Egredir has decreased dramatically, first due to the extinction of the A. leptodactylus population (crayfish plague outbreake), but latest caused by a serious decrease in the catch of S. lucioperca (Ozen et al. 2008). In Latvia, where the species is native, a commercially important coastal fishery takes place. The annual catch is 30 - 80 tons, mostly in the southern part of the Gulf of Riga. The species is also a quite common catch for anglers in some freshwater bodies, mainly in the areas where it is regularly restocked (Nature in Latvia).
Even though studies in Denmark have shown that the predation from *S. lucioperca* can have an adverse effect on populations of anadromous salmonids and lake ecosystems, *S. lucioperca* is still protected by the Danish Fishery Act by both a closed season and a minimum size limit, due to its importance to commercial and recreational fisheries.

Management approaches

Prevention methods
To prevent *S. lucioperca* from being introduced into lakes and rivers where it is not presently found, and where introduction is not desirable, stocking is not permitted in Denmark. In rivers and lakes where *S. lucioperca* is already present and has an adverse effect on populations of *e.g.* sea-trout, removing the protection of *S. lucioperca* could be considered, by eliminating the closed season, by removing the minimum size limit or by selective fishing.
In Finland many coastal and freshwater populations of *S. lucioperca* are over-exploited, and the main management concern has been the prevention of over-fishing by different technical measures, *e.g.* closed areas/seasons and gill-net mesh-size limitations (Lappalainen *et al.* 2005, Heikinheimo *et al.* 2006).

Knowledge and research
S. lucioperca is an integrated part of research on the structure and function of lake ecosystems and the effects of anthropogenic induced eutrophication. The adverse effects of *S. lucioperca* on the natural predators of lowland lakes mentioned above is not yet fully understood. The behaviour of *S. lucioperca* and the adverse effects of *S. lucioperca* on anadromous salmonids is an important research area, which has been the subject of several studies.

Recommendations or comments from experts and local communities
The general picture of the outcome of *S. lucioperca* introductions is two-sided. On the one hand, it is considered a success when evaluated from a commercial fisheries point of view, and it is in general (with the exception of anglers fishing for cyprinids in competitions) also considered a success from a recreational fisheries point of view (Crivelli 1995, Cowx 1997, Jacobsen *et al.* 2004). But on the other hand, the introduction of *S. lucioperca* has been found to have considerable, and often negative, effects on the fish community of the recipient environment (Brabrand & Faafeng 1993, Jepsen *et al.* 2000, Jeppesen *et al.* 2001, Koed *et al.* 2002 and others) and in some cases should be considered as an ecological disaster (Crivelli 1995, Cowx 1997).

Based on these findings, recommendations for future *S. lucioperca* introductions is this: If one wants to exploit the benefits of increased value of commercial fisheries and increased quality of recreational fisheries, one should be aware of and willing to accept the ecological consequences. These will occur and will most likely be substantial. Indigenous fish species will in most cases be affected negatively and might in some cases be extirpated. *S. lucioperca* populations stocked in rivers or in lakes connected to rivers with anadromous salmonids, can prey on descending smolts to a degree that can prevent the maintenance of self-sustaining populations. In shallow mesotrophic lakes with a native piscivorous species assembly consisting of perch and pike, perch being the pelagic predator, the perch population can be negatively affected. In both lakes and rivers reduced populations of planktivorous species, especially cyprinids, will often be the result. The behaviour of planktivorous species can be changed. When introduced, *S. lucioperca* is in general able to establish self-reproducing populations. Thus, in most of these cases the process and the changes described above is irreversible.

References and other resources

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Links

Facts on Fish (Nordic Council of Ministers)
Fishbase – Fact sheet on *Sander lucioperca*

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Date of creation/modification of this species fact sheet: 21-11-2006/ 06-02-2014